Towards Designing Energy-Efficient Routing protocol for Wireless Mesh Networks

Angeline G. DLUDLA, Ntsibane NTLATLAPA, T Nyandeni and Matthew ADIGUN
DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY OF ZULULAND
{ADludla, NNtlatlapa, TNyandeni}@csir.co.za and madigun@pan.uz.ac.za

Abstract— Different studies have proposed number of routing protocols to overcome data transmission challenges. Very few of these protocols consider node energy. In this study, the state of art work from various studies is reviewed and compared based on the some design criteria that are proposed in this paper. This paper proposes a new routing protocol that will prioritizes on energy efficiency. This protocol will be formulated using the HWMN protocol as the default protocol, together with other two protocols that has better characteristics on the other criteria. The formulated protocol is hoped to assist in saving energy in the WMN.

Index Terms—Wireless Mesh, Routing Protocols, Table-Driven, On-Demand-Driven.

I. INTRODUCTION

Wireless Mesh Networks (WMN) have emerged as a promising design paradigm for wireless networks [1]. WMN consist of the three types of nods: *mesh routers, clients and gateways* [2]. Each node operates not only as host but also as a router. This includes forwarding packets on behalf of other nodes that may not be within the direct wireless transmission range with their destination using the different routing protocols. A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select route between any two nodes on a computer network. There are many routing protocols that are designed for routing data packets from the source to the destination. These protocols also specify how the nodes in the network share information with each other as well as reporting changes. The routing protocols enable a network to make dynamic adjustments to its conditions; these decisions do not have to be predetermined and static.

Even though the routing protocols functions are plausible, they still face challenges in energy efficiency. There is therefore a need for a routing protocol that will be energy efficient and also scalable. Currently, nodes in the network are battery powered, during the routing; these protocols use battery's power. This paper investigates various demand-driven routing protocols in formulating a protocol that will consider energy efficiency. The reviewed protocols are compared using the basic routing characteristics, and the proposed protocol is designed to overcome some of their shortcomings, more specifically energy efficiency.

The rest of the paper is structured as follows: section II explores the related works, section III discusses the proposed model and section IV concludes the paper.

II. RELATED WORK

The routing protocols may be categorized into three, namely: Table-driven, the Demand-driven and the Hybrid routing protocols [4]. The table-driven routing protocols are also known as proactive routing protocol; each node maintains one or more tables which have routing information to all other nodes within the network [4]. Demand-driven well known as reactive routing protocols creates routes only when desired by the source node [5]. The hybrid routing protocols combines both the table-driven and the Demand-driven routing protocols to transport the packets from the source to the destination. It takes both the advantages of table-driven and on-demand-driven routing protocols. In the table-driven protocol, all nodes update each other on the same network and further update their tables to maintain a consistent and up-to-date view of the network. For the demand-driven protocols, when a node requires a route to its destination, it initiates a route discovery process within the network. The process is completed once a route is found or all possible route permutations had been examined [4]. One of the popular Hybrid routing protocol in the WMN is Hybrid Wireless Mesh Protocol (HWMP). This is a default routing protocol for IEEE 802.11s, which is consists of two features, namely: it is table driven; and also an on-demand protocol. This protocol is based on the protocol called RM-OADV (Radio Metric-Ad Hoc on-Demand Vector) routing protocol, which is the extension of AODV. It uses the same route discovery mechanism as that used by AODV and Dynamic Source routing (DSR).

Different studies have evaluated the performance of the various routing protocols. The research work reported on [11] compares the performance of Destination-Sequence Distance Vector (DSDV) [4], Dynamic Source routing (DSR) [4], Ad Hoc on-Demand Vector (AODV) [6] and Temporary Ordered Routing Algorithm (TORA) [5]. These protocols were simulated, and the results proved that the performance results of AODV, due to the limited information and TORA was not considered because of the more route request it generates. This study compared DSR and DSDV, and used two performance metrics, 1) network goodput and 2) node termination rate. The network goodput is the number of data packets successfully sent and received by the entire network within a certain period of time, node termination rate shows trends death due to the drain out of energy. The simulation result shows that light density on DSDV is comparable with DSR, while DSDV outperforms at higher node density. This is because of the high overhead incurred by the DSDV when maintaining routing tables.

Royer and Chai-Keon [3] reviewed and compared the results of the current routing protocols, both the table-driven

and demand-driven protocols. On the table-driven protocols, they analyzed the DSDV, Cluster Gateway Switch Routing (CGSR), and Optimized Link State Routing (OLSR) [3]. While on the demand driven, the AODV, and DSR, and routing protocols were reviewed [3]. The DSDV seemed to be inefficient in transmission because of the requirements of updating transmission regardless of the number of changes in the network topology. In CGSR, DSDV is used as the underlying routing protocols. The advantage of CGSR is that several heuristic protocols can be employed to improve the protocols performance. The WRP differs from the other protocols as it was found to require each node to maintain four routing tables [5]. During link failures, WRP illustrated lower time complexity than DSDV since it only informs neighboring nodes about link status changes. In terms of communication complexity, the DSDV, CGSR and WRP use distance vector shortest path routing as the underlying routing protocol, they all have the same degree of complexity during link failures, and DSR is potentially larger than that of AODV.

The Hybrid wireless Mesh Protocol (HWMP) [7, 8] is proposed as the part of extensibility framework for IEEE 802.11s WLAN mesh networks. The aspect of Energy efficiency aspect is considered as the major issue in this study as other studies overlook at it, and considering that the existence of the nodes in wireless mesh networks somehow depend on it. Currently, nodes are battery powered, and as nodes send or receive packets, the energy on the nodes decreases. This study therefore focuses on formulating the protocol that will consider energy efficiency on the ad hoc nodes during transmission. Table 1 is based on the three design criteria defined in this paper, namely energy efficient, scalable and robustness. The time driven protocol seem not to comply on the stated design criteria while the demand driven performs well on them except for the energy efficient.

Table 1: Comparison of Routing Protocols

Routing protocol	Protocol Type	Energy Efficient	Scalable	Robust
DSDV	Table-Driven	No	Yes	No
OLSR	Table-Driven	No	Yes	No
BATMAN	Demand-Driven	No	Yes	Yes
AODV	Demand-Driven	No	Yes	Yes
DSR	Demand-Driven	No	Yes	Yes
TORA	Demand-Driven	No	Yes	Yes
HWMN	Demand-Driven	No	Yes	Yes

III. PROPOSED RESEARCH APPROACH

This research intends to design the energy efficient routing protocol for WMN, based on IETF [7] energy efficiency framework. The propose protocol will be inspired by HWMP, DSR and AODV routing protocols. This is from the comparison made between two different routing protocols using the three criterions. The proposed protocol will fall under On-Demand Energy Efficient Routing Protocol as it will be composed of the demand-driven protocol. The performance of the newly proposed routing protocol will be evaluated through the simulation using the network simulator (NS-2) [4] and the test-bed implementation using the MERAKA test-bed [2].

III. CONCLUSION

Various routing protocols have been proposed by different studies but the energy is still a challenging issue for the WMN Routing protocols. Based on the different studies that have been conducted by various researchers; this paper proposes the new protocol which is believed to be more energy efficient to overcome some of the existing protocols' shortcomings. In future, an energy efficient routing protocol will be designed and further simulated to evaluate its performance.

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